

7 • What instruments and apparatus are required for determining the pollen concentration in air by means of the settling method?

A microscope with a field of known area and a glass slide coated with a viscous material.

8 • Describe the procedure for determining the pollen concentration in air by means of the settling method.

A glass slide coated with a viscous material is placed for a period of 24 hours in a horizontal position in the atmosphere to be tested. The slide is then removed and placed under the microscope, and pollen counts are made of approximately 25 fields over the area of the glass slide. Having determined the count over a definite area, as for example, 1 sq cm, and finding the settling rate of the average particles from the chart, Fig. 1 in Chapter 4, the concentration in parts per cubic yard can be calculated.

9 • The resistance to air flow of a unit air filter is found to be 0.4 in. of water. The volume of air passing through the filter is 1000 cfm at a velocity of 200 fpm. What would be the filter area required in order to reduce the pressure drop across the filter from 0.4 in. of water to 0.16 in. of water?

Referring to Fig. 2: The resistance is substantially proportional to the square of the velocity, or

$$\begin{aligned}\frac{R_1}{R_2} &= \frac{V_1^2}{V_2^2} \\ \frac{0.4}{0.16} &= \frac{200^2}{V_2^2} \\ V_2 &= 126.5 \text{ fpm} \\ Q &= AV \\ 1000 &= 126.5 A \\ A &= \frac{1000}{126.5} = 7.91 \text{ sq ft}\end{aligned}$$

The filter area would be increased from 5 sq ft to 7.91 sq ft.

10 • A ventilating system complete with filters has a fan which, when operating at 400 rpm and delivering air at 1 in. of water total static pressure, requires an input of 3 horsepower. After the system operates for a time, the pressure drop across the filter caused by the clogging action of the collected dust and dirt increases from 0.1 in. of water to 0.4 in. of water. To maintain the original rate of air delivery with the increased static pressure, at what speed must the fan be run and what horsepower will be required?

Static pressure after clogging of filter = $1 + (0.4 - 0.1) = 1.3$ in. of water.

The static pressure varies as the square of the fan speed. Therefore, if X is the fan speed after the static pressure increases:

$$\begin{aligned}\frac{1.3}{1} &= \left(\frac{X}{400}\right)^2 \\ X &= 456 \text{ rpm.}\end{aligned}$$

The horsepower varies as the cube of the fan speed. Therefore, if Y is the horsepower after the static pressure increases:

$$\begin{aligned}\frac{Y}{3} &= \left(\frac{456}{400}\right)^3 \\ Y &= 4.44 \text{ horsepower.}\end{aligned}$$

To maintain the original rate of air delivery with the increased static pressure, the fan speed must be increased from 400 to 456 rpm, and the horsepower from 3 to 4.44.

Chapter 27

FANS

Classification, Performance, Fan Efficiency, Characteristic Curves, System Characteristics, Selection of Fans, Volume Control, Fan Designations, Motive Power

IN heating and ventilating practice, fans are used to produce air flow except where positive displacement is required, in which case compressors or rotary blowers are used. Fans are classified according to the direction of air flow as (1) *axial flow* or *propeller* type if the flow is parallel with the axis, and (2) *radial flow* or *centrifugal* type if the flow is parallel with the radius of rotation.

Axial flow fans are made with various numbers of blades of a variety of forms. The blades may be of uniform thickness (sheet metal), either flat or cambered, or may be of varying thickness of so-called aerofoil section (airplane propeller type). Where an axial flow fan is intended for operation at comparatively high pressures the hub sometimes is enlarged in the form of a disc and the fan is known as a *disc fan*.

Radial flow or *centrifugal fans* include steel plate fans, pressure blowers, cone fans, and the so-called multiblade fans. All the foregoing types have variations which may be obtained by modification of the proportions or change in the curvature and angularity of the blades. The angularity of the blades determines the operating characteristics of a fan; a forward curved blade is found in a fan having slow speed operating characteristics, while a backward curved blade is found in a fan having high speed operating characteristics.

A wide variation exists in the demands which have to be met by fan installations. A fan may be required to move large quantities of air against little or no resistance or it may be required to move small quantities against high resistances. Between these two extremes innumerable specific requirements must be met. In general, fans of all types in each general class can be made to perform the same duty, although mechanical difficulties, noise or lack of efficiency may limit the use to one or another type. The most common field of service for fans of the propeller type is in moving air against moderate resistances, especially where no long ducts or heavy friction must be overcome and where noise is not objectionable, whereas centrifugal fans are commonly employed for operation at the comparatively higher pressures and where extreme quietness is necessary.

FAN PERFORMANCE

Fans of all types follow certain laws of performance which are useful in determining the effect of changes in the conditions of operation. These